would apply to the platform operators but rarely to the platform itself. To date, this funding limit has only seldom been reached in the German crowdfunding sector.

At EU level, several directives are under way or in the planning phase, including the Prospectus Directive[129] and the AIFM Directive. When it comes to implementing these directives at national level, it will have to be ensured that regulations aim to support the development of a crowdfunding industry in Germany as a whole, instead of unilaterally protecting the rights of investors. Nonetheless, it will be difficult to equally accommodate all the different types of crowdfunding with one relevant directive. Here, a specific Crowdfunding Directive might also be worth considering – similar to the provisions for funding portals in the context of the Jumpstart Our Business Start-ups (JOBS) Act 2012, which created a legal basis for crowdfunding in the United States.[130] The US directive entails raising the ceiling for crowdfunding financing to USD 1 million – a multiple of the limit at which the prospectus requirements in Europe take effect (i.e. EUR 100,000, as described above).

Recommendations

- For start-ups and SMEs, crowdfunding offers an attractive alternative to or supplement for financing by the government, banks, venture capitalist providers or business angels. Crowdfunding thus has the potential to stimulate innovation. Crowdfunding is a very recent phenomenon and still remains under-researched. Outstanding issues include e.g. the question of how the current government funding of start-ups and SMEs can be combined with this new financing form, and the ways in which crowdfunding affects the acquisition of follow-up financing. It is in the interest of all stakeholders to gather comprehensive data to facilitate enhanced transparency regarding the pros and cons of crowdfunding.
- Examples from other European countries suggest that the entrepreneur's chosen legal structure can hinder equity-based crowdfunding activities. In other countries, crowdfunding activities of start-ups that are based on more private-bound legal structures often require notarial formalities, or widely diversified equity is altogether prohibited in crowdfunding ventures. In contrast, the existing German regulations on silent partnership seem to be a locational advantage and are therefore deemed positive by the Expert Commission.
- The new provisions of the United States' JOBS Act have significantly improved framework conditions for crowdfunding activities in the United States, thereby also improving the environment for innovative SMEs and start-ups. To prevent Europe from falling behind the United States, it is ever more important to harmonise regulations at a European level or at least strengthen coordination of national crowdfunding-related regulations. Among other things, this concerns the monetary ceiling for prospectus requirements.
- It will have to be clarified how, on the one hand, individual investors can be protected and how, on the other hand, platform operators can be protected from fraudulent investors – without government intervention impeding the growth potential of crowdfunding markets in Germany and Europe.[131] Strengthened investor protection could be achieved e.g. by introducing a cap on allowable investment by individual private investors or by demanding explicit involvement of experienced and accredited investors in a financing project.[132]

EVALUATION OF INNOVATION POLICY MEASURES BASED ON RAMDOMISED EXPERIMENTS A 6

The core of the problem

In Germany, as in many other countries, a variety of policy measures are in place to increase the dynamics of R&D growth. Yet a systematic evaluation of such measures which complies with most recent scientific standards is still lacking. There is still a shortage of solid findings on the causal impact of different policy measures. An area that is particularly under-researched is the extent of windfall profits in comparison with causal effects of innovation policies. As it is paramount that scarce public funds are used both efficiently and effectively, a solid analysis of the causal effects of public R&D policy measures becomes even more compelling. Although in recent years, a number of studies have contributed to improving the evaluation of R&D support measures,

systematic causal evaluations are still lacking in innovation research. In other policy areas, such as labour market research, considerable progress has been achieved over the last decades in analysing the causal effects of public policy measures. This has lead to the identification and subsequent termination of major inefficiencies.[133] Between 2000 and 2005, approximately EUR 45 billion were invested in active labour market policies,[134] many of which were evaluated as being ineffective and were thus revoked during the 2009 reforms. The Expert Commission thus recommends that future innovation policy should also place a stronger focus on evidence-based innovation policies and systematic empirical analyses of causal effects.

Whether it is labour market, health or innovation policy measures: a general problem with such evaluations is that the counterfactual scenario cannot be observed once policy measures have been implemented. This means that it will never be possible to estimate how the beneficiaries of a public policy would have behaved in the absence of this policy intervention. As the beneficiaries are actually receiving public support, they cannot be observed in their non-supported status and therefore they cannot be used as a benchmark for assessing the effect of the policy intervention. For innovation policy evaluations this e.g. means that it is not possible to observe how patenting activities of companies with public support would have developed in the absence of this support. In such a case, the causal effect of policy measures can only be evaluated by comparing the patents of a group of supported companies (the "treatment group") with the patents of a group of similar peer companies that have not received support (the "control group"). This is a method similar to the experimental designs employed in the evaluation of new drugs (cf. Box 6).

For evaluations of innovation policies based on the comparison of treatment and control groups, the main difficulty is to precisely identify a group of non-supported control companies that are similar in all but one variable, that is, the support measure. For observable characteristics such as company size, age, or industry, it may still be relatively easy to find similar companies. It is more difficult, however, to identify companies that are similar in characteristics that are unobservable but nonetheless highly relevant for the effect of a R&D support measure. Such unobservable characteristicis could e.g. be leadership skills among R&D management, R&D staff's skills and motivation, as well as organisational learning capacities or a company's flexibility. If companies are not totally identical with regard to these important, yet unobservable characteristics, it will not be possible to assess whether a higher innovation output of a supported company, as compared with that of a non-supported company, is caused by the support measure. In fact it is possible that the innovation output of the supported company fully originates from differences in unobservable characteristics and is altogether unrelated to the policy measure. If for instance the group of supported companies is characterised by better leadership and more motivated R&D staff in comparison with the control group, differences in innovation output may be fully attributable to these soft factors alone, while the R&D policy measure might not have generated any effect at all. In such a case, public policy measures may simply be exploited as windfall profits because well-managed, highly motivated R&D staff are also more skilled in exploiting funding opportunities. As a consequence, a policy measure's causal effect would be completely different for de facto non-supported companies than for supported companies: if the public policy measures were extended to other companies, the effect would equal zero in the simplest case scenario and could even be negative in a worst case scenario. Hence it is essential to identify a suitable control group for the evaluations of causal effects of public policy measures.

Evaluations based on randomised assignments of companies to control and treatment groups

In the view of the Expert Commission it is a very promising way for the evaluation of specific R&D policy measures to randomly assign enterprises to the group of supported and non-supported enterprises. The random assignment ensures the existence of suitable control groups for high-quality evaluations.[135] A sufficient number of cases (enterprises) that are generally eligible for funding[136] must be randomly assigned to a control group and a supported group (treatment group), in order to ensure that these two groups are almost certainly statistically identical in all observable and unobservable variables – with the exception of the "supported" and "non-supported" characteristic. Differences in innovation output

BOX 06

Randomised evaluations in the field of drug development

Evaluations based on the principle of random assignment ("randomisation") can be compared with medical tests on the efficacy of a drug: one group of patients is administered a drug (treatment group), and a second group of patients is administered no drug or a placebo (control group). If the patients are strictly randomly assigned to both groups, it can be assumed that the two groups are identical with regard to their observable and unobservable characteristics. Hence differences between the two groups regarding the course of disease can be attributed most certainly to the causal effect of the drug. Thus it can be ruled out that differences in therapeutic success merely stem from the fact that e.g. persons with a different initial diagnosis or different financial resources or different socioeconomic status might have systematically decided for or against the treatment. However, differences in the patients' state of health do not allow for conclusions on the drug's efficacy if, for instance, only wealthy individuals living in a comprehensive care environment would have opted for treatment, while everyone else would have refrained from treatment. In such a scenario it could not be distinguished whether the positive course of disease is attributable to the use of the drug or to the more favourable care environment. In fact, it might even be the case that the overall effect is attributable to the favourable care environment, while the drug itself might be altogether ineffective. Thus, if patients are not randomly assigned to treatment and control groups, the positive course of disease does not allow for any conclusions on the drug's effectiveness.

can then be interpreted as causal results of the policy measure and not just as the result of differences in innovativeness stemming from other variables. A randomised assignment of applicants to control groups and treatment groups – similar to clinical trials preceding the launch of a new drug – would make it possible to identify the causal effect of a new support measure in the field of innovation policy. After this *causal* effect has been identified, it will be possible to determine the effectiveness and efficiency of a policy measure. Subsequently, it will be possible to derive economic conclusions for the future design of support programmes.

Random assignment procedures and rationing

In this context, random assignment procedures should not be mistaken for non-specific innovation support policies, i.e. distributing funds in an arbitrary and non-selective way. Random assignment procedures do not abandon eligibility and application criteria or qualified, expert-based selection processes.[137] Instead, the group of (suitable) applicants will be subjected to a lottery or a similar random assignment procedure. In general available funding sources are limited, and thus it is also in current assignment procedures rarely the case that all of the potentially suitable candidates receive funding. This means that randomised procedures do not produce additional losers. The only difference is that all those suitable candidates who did not succeed are assigned on a strictly random basis by means of a lottery procedure, i.e. all of the equally qualified candidates face the same likelihood of being affected by rationing. Nowadays, lottery procedures are by no means uncommon in other policy areas affected by rationing. In the field of medicine for example, a certain proportion of university places are allocated based on a lottery draw[138], or Berlin's education authorities allocate scarce places for secondary and upper-secondary schools by means of lottery draws[139], or revenue offices randomly select small and medium-sized enterprises to conduct routine audits.[140] In the field of innovation policy, random assignment would allow causal evaluations of policy measures. Hence, in the long term, all enterprises – and not only the selected ones – would benefit from these procedures because limited funding sources would be used more efficiently.[141]

The evaluation practice currently used in German and European innovation policy is often solely based on identifying statistically observable differences between supported and non-supported enterprises, or analyses interdependencies based on econometric methods by adding various control variables.[142] Here the problem is that observed differences are not necessarily causal results of the policy measure, but rather of the fact that, from the outset, different types of companies did or did not apply for funding. While the inclusion of observable control variables may

reduce the scope of the problem, it does not provide an overall convincing solution to the problem, because major differences in unobservable characterisitics may still exist, e.g. stronger leadership skills among R&D management or more favourable organisational learning capacities. Based on realistic assumptions, such criteria cannot be captured even by extensive data collection. Therefore, an improved innovation output of supported enterprises cannot be interpreted as a causal result of the policy measure.

While newly developed, more elaborate econometric methods[143] may be better suited to solving the problem of causality, these methods are still limited due to high data requirements and considerable statistical uncertainty. It is therefore not surprising that the assessment of policy measures in the evaluation literature varies greatly depending on the evaluation method used.[144]

In comparison, evaluations based on random assignment procedures are highly persuasive and valid, as results are easily understood (cf. Box 7). The causal effect of a policy measure ("treatment effect") is the difference in innovation output of two groups: a group of supported enterprises and a group of non-supported enterprises. Any additional, highly complex statistical practices and assumptions that would complicate a straightforward interpretation of results – but are common and necessary in the econometrically advanced practice of evaluation – can thus be omitted. However, it is important to ensure the strictly random assignment of enterprises to treatment and control groups. In addition, both groups have to be sufficiently large to allow for statistically powerful conclusions about the effectiveness of a measure.

Depending on the initial situation of the policy measure to be evaluated, it might make sense to randomly assign all applicants to a control group and a treatment group. Alternatively, only a certain proportion of applicants may be included in the lottery draw, as it is e.g. the case in the assignment of university places in medicine. Thus, in randomised evaluations in the field of innovation policy it could be decided e.g. to confine random assignment only to a certain proportion of applicants if one can be sure in advance that the respective measure will have maximum effect for a top group of clearly eligible applicants, but not for all applicants in general. The small top group would be selected first, while random assignment would be confined to the larger remaining group or to a group of borderline cases. When applying such a mixed approach, one has to bear in mind that statistically valid conclusions on the effect of the funding instrument can only be made for these borderline cases and, even more importantly, that these borderline cases may not be compared with the top group. In view of this, the best possible evaluation results might be achieved through total randomisation of all cases for a limited period of time. Total randomisation can also be useful whenever no or only a few reliable preselection criteria are available. Moreover, policy evaluations based on randomised award procedures following the launch of a policy measure have the advantage that they not only determine whether supported companies outperform non-supported companies, but that they can also be used to compare different designs of a funding instrument with the aim of identifying those designs that are relativley more cost-efficient or more effective – provided that the number of cases is sufficiently high. If necessary, it can then be decided in the policy-making process which of the criteria should be given more relevance. Thus policy evaluations based on randomised award procedures following the launch of a policy measure can provide comprehensive information to improve public R&D policies in certain areas.

Concerns about randomised evaluation procedures

In political practice, the introduction of evaluation procedures using random assignment is often met with ethical concerns and concerns relating to public procurement law – despite its diverse methodological advantages. Thus it is argued that a random assignment to supported and non-supported groups would not be compatible with the applicable public procurement law. However, this line of thought neglects the fact that oversubscribed support programmes also require additional selection criteria (such as the "first come, first served" principle or regional allocation criteria) – the effects of which can be somewhat arbitrary indeed. Moreover, ethical concerns have been expressed regarding a lottery draw system, arguing that such procedures would fuel injustices. However, these critics seem to ignore that it is not the lottery procedures but the

rationing itself that causes some of the individuals or enterprises not to be supported. In fact, the lottery draw system even ensures that the probability of not being supported is the same for all applicants. On the contrary, random assignment procedures in fact prevent applicants from having higher initial chances than others, owing to traditional selection criteria that are sometimes questionable in terms of their content or statistical basis. Such issues and concerns can be largely eliminated through the prudent implementation of ramdomised procedures and through clear communication policies, as has been demonstrated in other countries such as the Netherlands.[145]

Several European countries recently started introducing random assignment procedures for single policy measures in science and innovation. Examples include the issuing of innovation vouchers to SMEs in the Netherlands[146] and in several pilot regions in the UK. The evaluation of these new measures, which aim to stimulate technology transfer between industry and science, shows a short-term increase in the number of contractual cooperation agreements. The results also provide a clear picture of the extent of windfall profits: i.e., it has been shown that about one out of nine projects would have been implemented even without the voucher.[147] The Netherlands also introduced random assignment procedures in the context of innovation loans and research grants for young scientists. Thus, in future, it will also be possible to draw reliable conclusions on the effect of such programmes.

BOX 07

Randomised evaluations in US education policy

Policy evaluations based on random assignment procedures have been an instrument of US education policy for several years.[148] Thus, for instance, a highly cited study in the state of Tennessee[149] discusses the long-term effects of introducing small class sizes versus full-time or part-time teacher aides on educational outcomes. At the launch of the measure, students were randomly assigned to classes of different sizes, and classes with or without full-time or part-time aides respectively. The study concludes that, on average, students perform significantly better in small classes (also in the long term), while the integration of a part-time teacher aide has no effect on students' performance. These reliable and reproducible findings from the evaluation of the policy contributed to political discourse which largely resulted in more than a dozen US states subsequently reducing class sizes and dispensing with the costly use of teacher aides and thereby ensuring greater efficiency of allocated funds.[150]

Randomised evaluation procedures: applications and its limits

Although randomised evaluation procedures can be widely applied, they are not equally suitable for all policy areas.[151] As a rule, randomised procedures are more suited to support programmes in science and innovation policy designed for a large number of participants, as only this will guarantee a sufficient statistical power. A sufficient number of supported and non-supported enterprises is an essential prerequisite for producing statistically powerful results regarding potential differences existing between control and treatment groups, and for reliable estimations of the causal effect of the measure. Hence, for certain programmes, such as support programmes for large-scale technology projects, randomised evaluation procedures will remain unsuitable. However, for programmes with a large number of applicants, the introduction of randomised procedures should be taken into consideration. Against the background of ethical and political acceptance concerns, support measures that are typically oversubscribed seem to be particularly suited to randomisation. In these cases in which the number of generally suitable candidates exceeds the total budget planned, it is an inevitable by-product of the programme that some of the applicants will walk away empty-handed. Based on this, randomised procedures can primilary help to reduce ethical concerns relating to randomised awarding. Furthermore, it is important that a programme's objectives are clearly and explicitly defined if randomised evaluation procedures are to be employed. Only then will it be possible to unequivocally measure a programme's success. Thus, policymakers have to ensure that a programme's objectives are measurable and clearly defined before the launch of the scheme, thereby establishing relevant criteria for assessing that the programme is a success.

Against this background, there are currently several Federal innovation support programmes for SMEs that are generally suited to randomised evaluation procedures, among them e.g. the Central Innovation

Programme for SMEs ("ZIM" programme) or the "KMU-innovativ" programme. The same applies to existing start-up support programmes and the awarding of research grants to individual scientists, such as the EXIST start-up grant or the DFG's foreign scholarship programmes for young scientists. In all of these fields, randomised procedures could generate important insights into a policy measure's effectiveness and would help to gain valuable experience in dealing with randomised evaluation procedures. In terms of the economic value of findings, randomised evaluations could be highly beneficial to the Federal Government's support scheme for small and medium-sized enterprises due to the high funding volume in this policy area. For the year 2013, and presumably for the year 2014 as well, funds amounting to approximately EUR 500 million per year have been allocated in the federal budget for the ZIM programme.[152] Here, even a slight improvement in the allocation of funds could generate a substantial effect.

Yet the use of randomised evaluation procedures is also limited, despite all the advantages it has to offer. One of the major limitations in the use of evaluation findings is that it is not always possible to generalise results. Ideally, each new instrument design and each instrument applied to a new context should be introduced based on its own random assignment. The effect of an instrument on selected applicant enterprises, even if they are selected very carefully, can only rarely be transferred to those enterprises that have never applied for funding previously or that have only applied for funds elsewhere. Ultimately, this problem does not solely apply to randomised evaluations, but to any kind of evaluation procedures, i.e. it is a general problem that does not invalidate randomised evaluation procedures as such. It is often argued that another disadvantage of evaluations involving treatment and control groups lies in a potential knowledge spillover between supported and non-supported enterprises, resulting in an underestimation of the effect of the intervention when comparing the two groups. Again, this is a problem that may also occur in conventional evaluation procedures. Besides, the long-term collection of high-quality data is a prerequisite not only for randomised procedures, but for any evaluation process, because the validity of results essentially depends on the quality of the outcome measures, and the short-term and long-term comparisons. Additionally, a high-quality database of the population of potential funding recipients must be provided as part of a careful evaluation preparation. This will ensure that the lottery procedures and the assignment to control and treatment groups are laid out and determined on a statistically solid basis. Upon expiry of the funding period, relevant data from both supported and non-supported applicants must be collected and provided.

Policy recommendations

The Expert Commission recommends including evaluations based on randomised assignments as a standard tool in the evaluation portfolio of public R&D funding. A randomised introduction of policy measures is particularly suitable for areas where a relatively large number of applicants is anticipated and where an oversubscription of funds can be expected due to limited budgets. Randomised procedures entail the opportunity to gain valuable information about the effectiveness and potential future designs of an efficient support measure, thereby also facilitating the decision on whether a particular funding instrument should be consolidated and extended to other areas. Randomised evaluation procedures could thus lead to considerable efficiency gains and a better use of funds – provided that findings are integrated into the political decision-making process.

The Expert Commission recommends launching an evaluation on the basis of a randomised allocation of funds in the context of the ZIM funding programme supporting innovative SMEs. The objective is to generate knowledge regarding opportunities for increasing efficiency of this policy measure, and to accumulate experience in dealing with randomised evaluations. At a later stage, the experience gained can be systematically transferred to other fields of application.

Randomised award procedures for new policy measures are still rarely used in Europe. By embarking on such an intelligent, evidence-based approach to research and innovation policy, Germany could take on a leading role in this area in Europe.